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Odonata from the Republic of Mongolia and from the Autonomous Region of Inner Mongolia

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Abstract

Thirty-five dragonfly species are reported from Mongolia and Inner Mongolia. Three are first records. A non-parametric test is used to determine the total number of species to be expected. It suggests that the current number of 62 may be asymptotically complete, except for some specific zones like the Bulgan valley in the south-west, and the upper catchment of the Amur River, which have a distinctive fauna. From a biogeographic point of view, the Mongolian fauna is predominantly of impoverished Eurosiberian extraction. The south of Mongolia (the Gobi) and adjacent Inner Mongolia are, however, enriched with a significant fraction of East-Mediterranean and Irano-Turanian species, taking advantage of the Dzungarian corridor(s). This is particularly true of the fauna found in the small cis-Altai 'exclave' of the extreme south-west of the country. True Oriental species are rare, but East Palaearctic species (e.g. of the genus *Cercion*) are well-represented, especially south and east of the Gobi desert, which itself remains in need of further exploration.

Introduction

A major difference in the composition of the taxa and in species richness exists between the north (Siberia) and the south (Japan and much of China) of the East Palaearctic. Most of Siberia was never glaciated, yet the local climate during the Pleistocene glaciations was so harsh that only a limited number of dragonfly species managed to survive in this giant territory. In spite of postglacial reinvasion, which may have had complex origins, strong north-south gradients in species richness still characterise the fauna of Siberia today. A few among the 20 or so species found in north-east Siberia are endemic, e.g. *Coenagrion glaciale* (Selys), yet species richness only increases significantly in the south of eastern Siberia, in the basin of the Middle and Lower Amur and in Primorye, the coastal district near Vladivostok, where Haritonov & Malikova (1998) list over 70 species. The contrast with the Japanese Islands (ca 185 spp.), and even more so with China, is striking. The total number of species that live in China is still not accurately known (Needham 1930; Sui & Sun 1984), but is at minimum twice that found in Japan, and amply overshoots 600 taxa (Asahina 1961).

The present paper discusses the fauna found west and south-west of Primorye. Here lies the republic of Mongolia, in the very heart of the Asian continent, and, adjacent to it, the Chinese autonomous province of Inner Mongolia. Not only is this area extremely continental, but most of it is a plateau, shielded off to the north and west by the mountain ranges of Sayhan and Altai, creating a huge endorheic basin that covers almost the entire western third of the republic of Mongolia (Fig. 1). A small part of southwestern Mongolia, drained by the Bulgan River, is situated west (cis) of the Altai chain (Fig. 1), and connects to the Urungu River in north-west China. This runs close to, and in parallel with, the upper Irtish River, that ends in Kazakstan. The 'Dzungarian connection' (the Dzungarian gates s.str. are situated south of the Irtish) thereby established is responsible for incursions of dragonfly species from the west into Mongolia, and sometimes far into the eastern zones of China (see below). One major River, the Selenga, drains Mongolia to the north, and establishes a contact with the Siberian plains. In the east, altitude levels off, and the headwaters of the Amur (Heilong) drain huge grasslands towards the Pacific Ocean. Like the Urungu-Irtish and the Selenga, the Amur provides a pathway through which dragonflies – mostly East Palaearctic species and mostly from the so-called Manchurian province – may enter Mongolian territory. Here the Onon and Kerulen (Cherlen), tributaries of the Amur, and large freshwater lakes like Hulun and Buir are found. The entire south half of the country, is occupied by the Gobi desert, confluent in the west with the Dzungarian basin, sandwiched between the Tien Shan and Altai ranges. The only major River that slightly penetrates the confines of the Gobi is the Huang He (Yellow River) which makes a northward bend right in the centre of the area, thereby creating a swampy 'internal delta'. This zone includes, among others, the freshwater wetlands of Ulansuhao (Wulianshuhai) in central Inner Mongolia.

Great faunal richness is only found south of 40°N, but this should not detract attention from the region situated between 40° and 50°N which, for the reasons outlined above, can be considered a faunal addition-subtraction area. Early studies about the dragonfly fauna of Mongolia have been reviewed by Krylova (1974), with important additions by Peters (1985), and a small but significant note on Darchan in the Selenga basin by Malikova (1997). A gazeteer of the two long expeditions by Peters was published by Piechocki & Peters (1966) and provides abundant pictorial material on the aquatic environments of Mongolia. Much information on the valley of the Onon River, straddling Dauria in Siberia and adjacent Mongolia, has been gathered by Kosterin (1999). For Inner Mongolia, an inventory by Ma et al. (1991) is available. For the fauna of Siberia as a whole, the reader should consult the monograph by Belyshev (1973a, 1973b, 1974). Here, I provide new information on Mongolia s.l., based on two trips (June 1999 and July 2000) to central and east Inner Mongolia ("Manchuria"), and one trip to the Selenga basin, Mongolia (July 2001), with some extra records provided by V.E. Alexeev (Mongolia, summer 1999), Xin Yan (Hohhot, July 2000), V. Clausnitzer (Mongolia, August 2001), and A. Brancelj (central Inner Mongolia, August 2002).

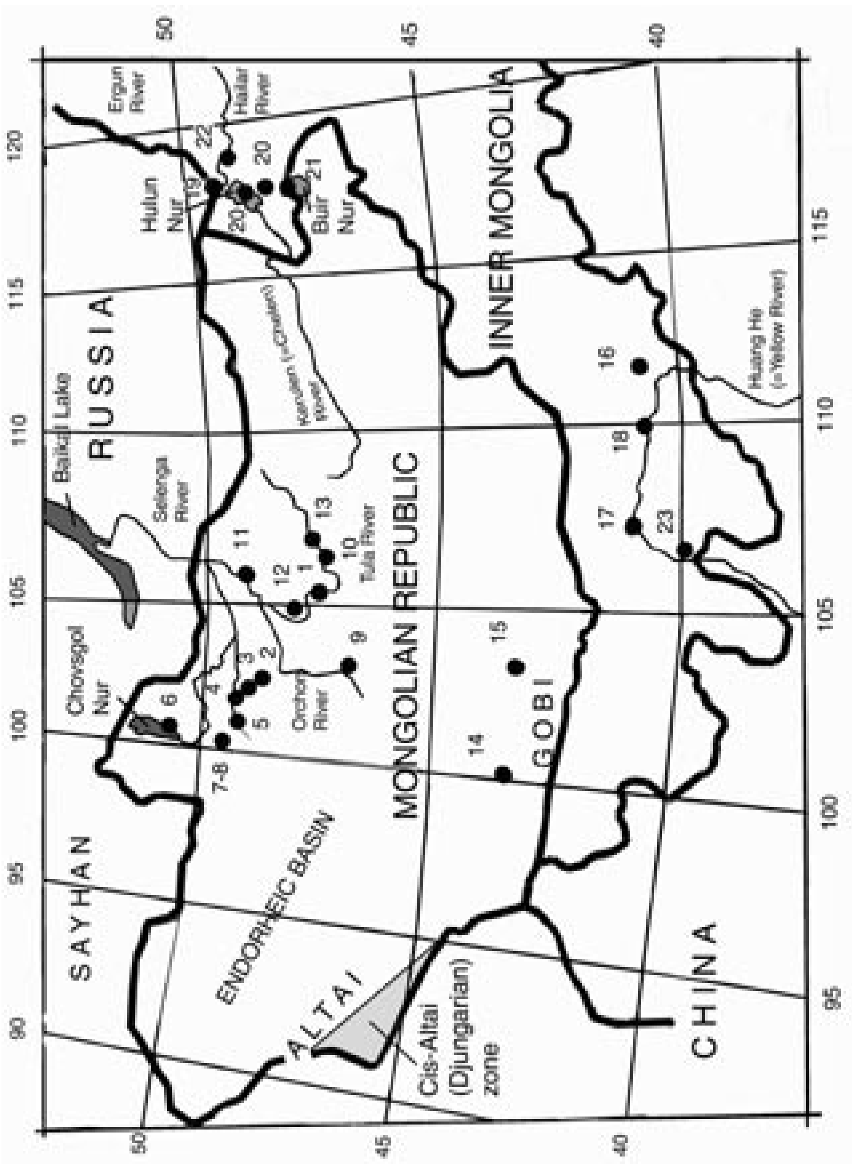


Figure 1. Map of Mongolia and Inner Mongolia, showing the main hydrographic network and the localities where dragonflies have been collected.

Material and methods

As often when exploring areas that are relatively difficult of access, a hit-and-run collecting technique was used. However, care was taken to attempt to capture all species sighted at all localities (26) visited, and usually two people collected simultaneously and independently of each other.

To evaluate species richness from the samples collected, I used non-parametric (distribution-free) techniques that evaluate true species richness from samples (Colwell & Coddington 1994). I selected Chao's estimator (Chao 1984) as well as first- and second-order jackknifing to estimate the total number of species present (S^*) from my n samples. This approach is based on the relationship between singletons (L) and doubletons (M), with S_{obs} the number of species actually found in n samples. A census is conventionally considered complete when no more singletons occur in a collection. Strictly speaking, the reasoning only holds for the environments explored, thus the Selenga and Upper Amur valleys, and central Inner Mongolia. The species found only in the cis-Altai exclave belong to a different fauna, and should be considered separately.

List of localities sampled (Fig. 1)

Republic of Mongolia

July 2001, leg. H. Dumont and J. Vermeir

1. Banks of Tula (Tuul) River at Lun (47°43'29"N, 105°50'25"E), 16 vii 2001.
2. Between Bulgan and Hutag-Ondor, swamp near River (49°31'58"N, 101°52'57"E), 18 vii 2001.
3. Small meandering River in grassland, with abundant littoral vegetation (49°00'39"N, 102°47'44"E, 1,200 m), 18 vii 2001.
4. Selenga River at ridge near Hutag-Ondor (49°22'51"N, 102°50'25"E, 960 m), 19 vii 2001.
5. Along Selenga, not far from In Uul (ca 49°26'N, 101°24'E), 19 vii 2001.
6. Khubsugol Lake (Chovsgol Nuur), swamps at SE end of the lake near Handigen Davaa (50°27'02"N, 100°12'51"E), 1,668 m, 20-22 vii 2001.

7-8. Ergol Nur salt lake, and second salt lake nearby in the vicinity of Moron (ca 49°39'N, 100°30'E), 22 vii 2001.

9. Ogiy Nur, a shallow swampy lake in the plain of the Orchon (Orkhon) River (47°43'03"N, 102°34'14"E, 1,314 m), 25 vii 2001.
10. Tula River valley, ca 30 km SW of Ulaan Bator, series of shallow ponds in gravely plain behind dyked section of the River (47°48'25"N, 106°36'58"E, 1,226 m), 26 vii 2001.

August 1999, leg. V. Alexeev

11. Lake Bur Nur near Darchan, N of Ulaan Bator (49°27'04"N, 106°16'07"E), 28 viii 1999.
12. Tula River near Gobd-Zamor (ca 48°20'N, 104°20'E), 26 viii 1999.

13. Ulaan Bator, Tula River (ca 47°53’N, 106°57’E), 25 viii 1999.

August 2001, leg V. Clausnitzer, det. V. Clausnitzer and R. Jödicke

14. Lake Zulgamei Gol (43°44’N, 100°02’E, 1,106 m), 14 viii 2001.
15. Tokhom Nuur (43°35’N, 103°08’E, 1,422 m), 25 viii 2001.

—. Also 13bis. Tula River at Ulaan Bator, 26 viii 2001.

Inner Mongolia (Nei Mongolia), China

June 1999, leg. H. Dumont and Su Rong, July 2000, leg. Xin Yan

16. Hohhot, water reservoir and small brook draining mountains behind city (40°50’N, 111°33’E), 23 vi 1999.

16bis. Fishponds of Fishery Research Station of Hohhot, vi 1999 and also vii 2000.

17. Wuliangsu Hai (ca 40°51’N, 107°55’E), lake-swamp in floodplain of northernmost bend of Huang He River, 19 vi 1999.
18. Fishponds at city of Baotou (ca 40°32’N, 110°00’E), 20 vi 1999.

July 2000, leg. H. Dumont & Su Rong

19. Manzhouli city (Manjuur), swamp in City park (49°35’N, 117°26’E), 22-23 vii 2000.
20. Hulun Lake (Dalai Nuur), several collecting stops on tour around the lake (ca 48°N, 117°E) and in wetlands along the Orshun River (48°25’N, 117°35’E) between Hulun Lake and Lake Buir Nur, 18-20 vii 2000.
21. Lake Buir Nur on Chinese-Mongolian Border, Chinese side (47°56’N, 117°39’E), 20 vii 2000.
22. Wetland on Sino-Russian border at confluence of Rivers Herlen and Hailar (ca 49°24’N, 118°31’E), 24 vii 2000.

August 2002, leg. A. Brancelj

23. Lake Daihai (40°39’30”N, 112°41’30”E), 10 viii 2002.
24. Lake Huang Qihai, (40°49’N, 113°12’E), 14 viii 2002.

Extra locality, August 1984, leg. Su Rong

25. Jilantai Lake at Linchang (Arzhuoqi district), south rim of Gobi desert in Huang He valley, 03 viii 1984 (see Dumont 1996).

Results

List of species and their occurrence at the localities

Numbers refer to localities. Specimens collected are given in brackets. Authorities of names of all Mongolian taxa are given in Table 1.

Lestes barbarus	14, 16 (♂).
L. dryas	3 (several ♂, ♀).
L. sponsa	1, 2, 6, 9, 10, 11, 13, 19, 20, 22.
Sympecma paedisca	3 (2 ♀), 12 (♀), 13, 15, 25 (♀).
Cercion hieroglyphicum	16, 17 (large numbers), 18, 19, 22, 23.
C. plagiosum	17 (large numbers).
Coenagrion ecornutum	2, 3, 19, 20, 22.
C. hylas	10 (♂).
C. johanssoni	3 (♂).
C. lanceolatum	1 (♀), 2, 6, 9, 10, 19, 20, 22.
C. lunulatum	2, 3, 6, 10, 16, 19, 20, 22.
Enallagma cyathigerum risi	6, 7-8 (massive numbers), 9, 10, 11, 12, 14, 16, 19, 20, 22.
Erythromma najas humerale	19, 22.
Ischnura elegans	17, 23.
I. evansi	25 (♀).
I. pumilio	14, 25.
Aeshna juncea	3 (two ♂), 6 (♀).
A. mixta	19 (♀).
A. sp. (*crenata* or *serrata*)	9 (♂, specimen not captured).
Anax parthenope julius	16, 17, 18, 23.
Ophiogomphus spinicornis	4, 5, 9, 11.
Deielia phaon	16, 18.
Libellula quadrimaculata	6, 16.
Orthetrum albistylum	17, 18.
O. brunneum lineostigma	14 (close to the nominotypical ssp.), 16, 18.
Pantala flavescens	16, 18, 23.
Sympetrum danae	1, 6, 13, 19, 20.
S. depressiusculum	19.
S. flaveolum	2, 4, 5, 6, 10, 11, 13, 19, 20, 22.
S. fonscolombii	16.
S. pedemontanum	2, 3, 5, 6, 9, 13, 15, 20, 22.
S. speciosum haematoneura	16 (2 ♂)
S. striolatum imitoides	1, 2, 4, 12, 15 (close to ssp. *pallidum*), 19, 20, 21, 24.
S. vulgatum	14, 15.
S. sp. (*risi* ?)	18.

Species richness

The number of singletons was 11, that of doubletons eight, S_{obs} was 35 and n was 25.

Chao's estimator is given by $S^* = S_{obs} + (L^2 / 2M)$ and suggests a total fauna of 43 species, i.e. about six were missed by our survey. The first-order jackknife estimate is based on the number of species found in only one sample and is given by $S^* = S_{obs}. + L (n - 1 / n)$. It leads to 46 species. The second-order jackknife estimate is again based on the number of singletons and doubletons:

$S^* = S_{obs} + \left[\frac{L(2n-3)}{n} - \frac{M(n-2)^2}{n(n-1)} \right]$. It leads to an estimate of a total of 55 species.

The concordance of the first two estimates is good, while the second order jackknife suggests a higher total, with up to 20 species missed by our surveys. On the other hand, it seems that the total number of species (62) of Table 1 is a reasonable approximation of the ultimate total for the Mongolias. However, this is not necessarily a robust conclusion, because this number includes the fauna of the cis-Altai enclave, which is Siberian-Turanian rather than Mongolian, as argued earlier. On the other hand, the degree of uncertainty on these estimates is also a function of the ratio *L* / *M*. A variance can be derived, dependent on *L* / *M*, which, in the case of Chao's estimator, is computed by

$$\mathrm{Var}\,(S^*) = M\left[\left(\frac{L/M}{4}\right)^4 + \left(\frac{L}{M}\right)^3 + \left(\frac{L/M}{2}\right)^2\right] = 24.6$$

The standard deviation of the "mean" (= the total species recorded) is thus about 5, such that the concordance between the total number of species on record with the species richness estimates is encouraging, but deserves further study. A reasonable conclusion from this exercise might be that the dragonfly fauna of Mongolia s.l. may now be considered relatively well known, say, within less than 20% of the asymptotic total.

Table 1. Odonata records from the Republic of Mongolia and from the Autonomous Region of Inner Mongolia. — KR: Mongolia, Krylova (1974); PE: Mongolia, Peters (1985); MA: Inner Mongolia, Ma et al. (1991); MK: Mongolia, Malikova (1997); DU: this paper.

	KR	PE	MA	MK	DU
ZYGOPTERA					
CALOPTERYGIDAE					
Calopteryx japonica Selys	-	-	X	-	-
C. splendens (Harris)	-	X	-	X	-
C. virgo (Linnaeus)	-	-	-	X	-
LESTIDAE					
Lestes barbarus (Fabricius)	X	-	X	X	X
L. dryas Kirby	X	X	-	-	X
L. macrostigma (Eversmann)	X	X	-	-	-
L. sponsa (Hansemann)	X	X	X	X	X
Sympecma paedisca (Brauer)	X	X	X	-	X
COENAGRIONIDAE					
Aciagrion hisopa (Selys)	-	-	X	-	-
Cercion hieroglyphicum (Brauer)	-	-	X	-	X
C. melanotum (Selys)[1]	-	-	X	-	-

Table 1. Continued.

	KR	PE	MA	MK	DU
C. plagiosum (Needham)	-	-	X	-	X
Coenagrion armatum (Charpentier)	X	X	-	-	-
COENAGRIONIDAE					
C. ecornutum Selys	X	-	-	-	X
C. hylas Trybom	X	-	-	-	X
C. johanssoni (Wallengren)	-	-	-	-	X*
C. lanceolatum Selys	X	X	-	-	X
C. lunulatum (Charpentier)	X	X	-	-	X
C. puella (Linnaeus)	-	X	-	-	-
Enallagma cyathigerum risi Schmidt	X	X	X	-	X
Erythromma naias humerale Selys	-	X	-	-	X*
Ischnura asiatica (Brauer)[2]	-	-	X	-	-
I. elegans (Vander Linden)	X	X	X	-	X
I. evansi Morton	-	-	-	-	X
I. pumilio (Charpentier)	X	-	-	-	X
I. senegalensis (Rambur)	-	-	X	-	-
ANISOPTERA					
AESCHNIDAE					
Aeshna affinis Vander Linden	X	X	-	-	-
A. crenata Hagen	X	X	-	-	?
A. grandis (Linnaeus)	-	X	-	-	-
A. juncea (Linnaeus)	X	X	X	-	X
A. mixta Latreille[3]	-	X	X	-	X
A. serrata Hagen	X	X	-	-	?
Anax parthenope julius Brauer	X	X	X	-	X
GOMPHIDAE					
Anisogomphus maacki (Selys)	-	-	X	-	-
Gomphus flavipes (Charpentier)	-	X	-	-	-
Ophiogomphus reductus Calvert[4]	-	X	-	-	-
O. spinicornis Selys[5]	-	X	X	-	X
MACROMIIDAE					
Epophthalmia elegans (Brauer)	-	-	X	-	-
Macromia amphigena Selys	-	X	X	-	-
CORDULIIDAE					
Somatochlora metallica (Vander Linden)	-	X	-	-	-

Table 1. Continued.

	KR	PE	MA	MK	DU
LIBELLULIDAE					
Deielia phaon (Selys)	-	-	-	-	X*
Leucorrhinia orientalis Belyshev	-	X	-	-	-
L. rubicunda (Linnaeus)	X	-	-	-	-
Libellula quadrimaculata (Linnaeus)[6]	-	X	X	-	X
Orthetrum albistylum (Selys)	-	-	X	-	X
O. brunneum lineostigma (Selys)	X	-	X	-	X
O. cancellatum (Linnaeus)	X	X	-	-	-
O. glaucum (Brauer)	-	-	X	-	-
Pantala flavescens (Fabricius)	-	-	X	-	X
Sympetrum danae (Sulzer)	X	X	X	-	X
S. depressiusculum (Selys)[7]	X	X	X	-	X
S. flaveolum (Linnaeus)	X	X	-	-	X
S. fonscolombii (Selys)	X	-	-	-	X
S. hypomelas Selys	-	-	X	-	-
S. meridionale (Selys)	-	X	X	-	-
S. pedemontanum (O.F. Müller in Allioni)	X	X	X	X	X
S. speciosum haematoneura Fraser	-	-	-	-	X*
S. striolatum imitoides (Selys)[8]	X	X	X	-	X
S. tibiale (Ris)	X	X	-	-	-
S. vulgatum (Linnaeus)	X	X	-	X	X
S. sp. (*risi* ?)	-	-	-	-	X*
Total	29	35	30	6	35

* New record for Mongolia or Inner Mongolia.

[1] The synonymy of *Cercion sexlineatum* with "*Enallagma" melanotum* Selys, advocated by May (1997), is here accepted.

[2] Synonym: *Ischnura lobata* Needham.

[3] Synonym: *Aeshna lucia* (Needham) (see Asahina 1988a, 1988b)

[4] Listed as *Ophiogomphus serpentinus* (Charpentier) (= *O. cecilia* [Geoffroy in Fourcroy], a 'European' species.

[5] For a discussion of the status of the European and temperate Asian representatives of this group, see Asahina (1979).

[6] Synonym: *Libellula basilinea* McLachlan.

[7] *Sympetrum frequens* (Selys), cited by Ma et al. (1991) from Inner Mongolia, is doubtful. True *S. frequens* occurs on the Japanese Isles, with *S. depressiusculum* over most of continental Eurasia. In Korea, a cline between both may exist.

[8] This taxon overlaps with *S. s. pallidum* Selys in the southwestern parts of Mongolia; see text.

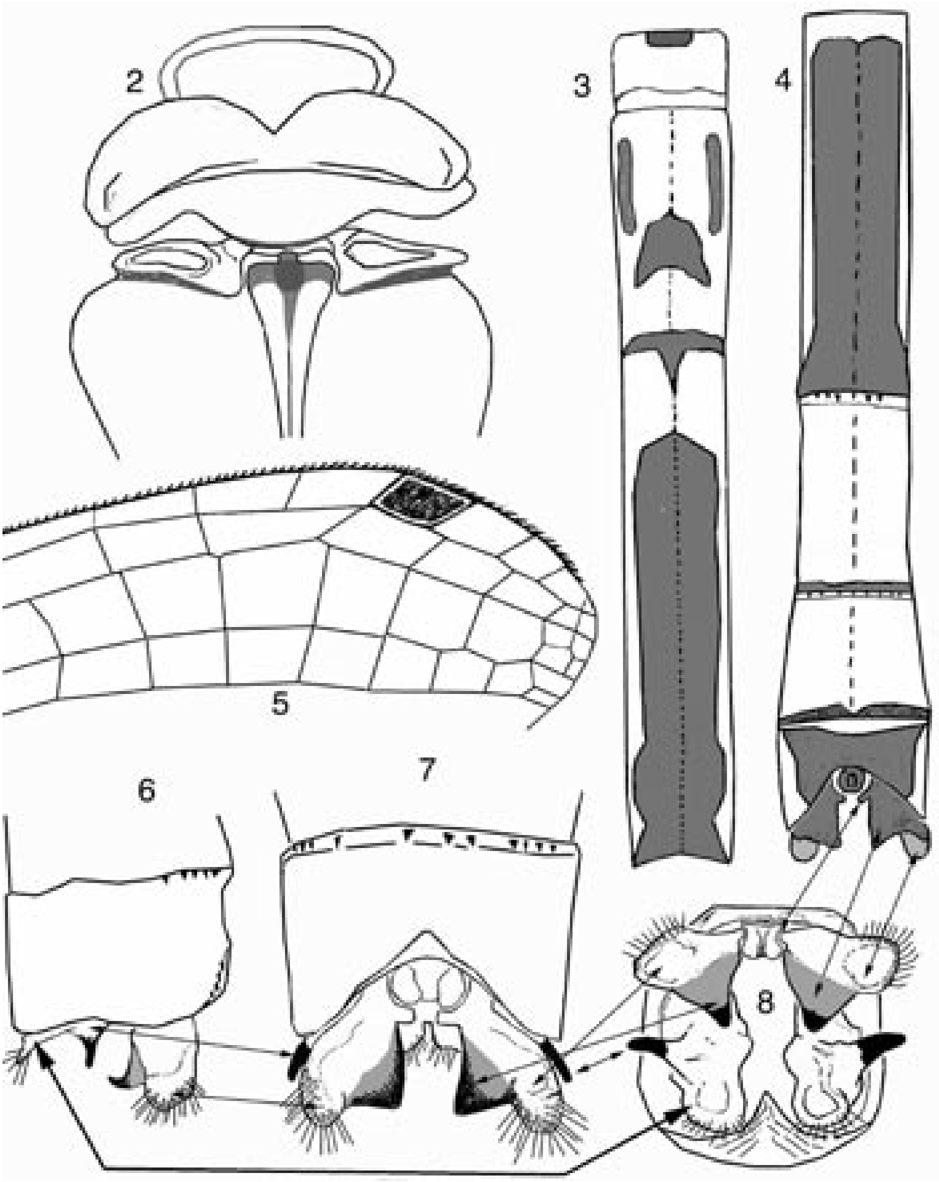
Discussion: composition of the regional fauna

One third (11 out of 35) species were only found at single locations (singletons), which suggests that, in spite of the generally extreme conditions of the Mongolian and Inner Mongolian environment, a fraction of the species is not composed of ubiquitous generalists. It is not unreasonable to assume that most of the singletons may be rather choosy about the kind of biotope in which they occur, although one caveat is certainly that we still have no idea about a possible seasonal succession of species in any given biotope.

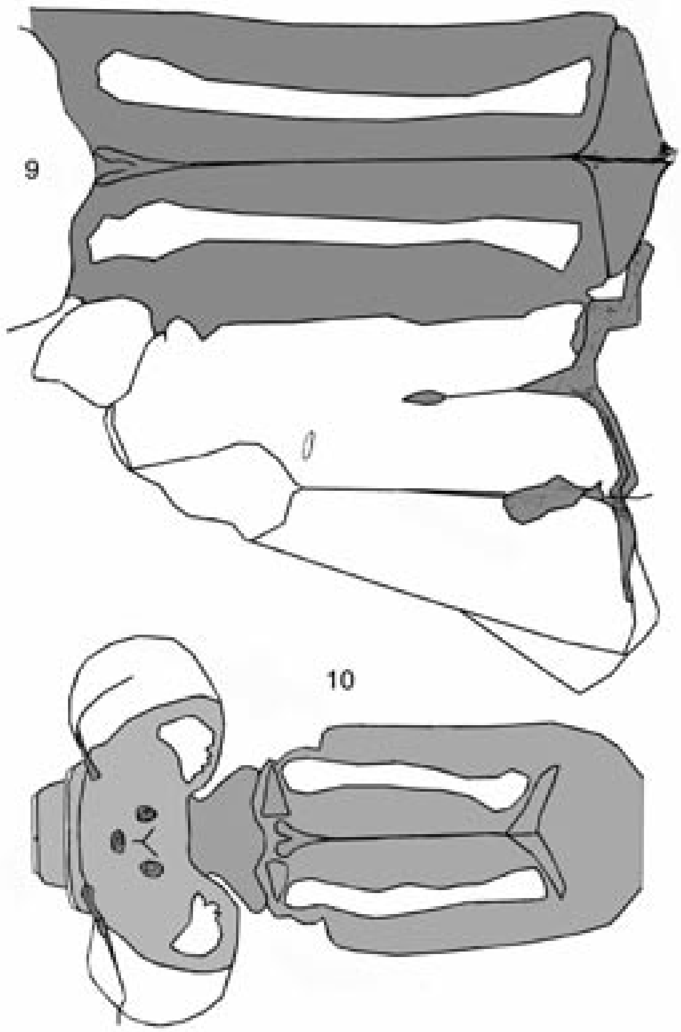
Lestids and coenagrionids dominate the Zygoptera, with the genera *Lestes* and *Coenagrion* dominant in the north, and *Cercion* in the south and east. *Ischnura* is rare in the north, a remark which also applies to Central Siberia (Belyshev 1973b) but it has at least three species in the south-west. *Enallagma cyathigerum,* with a subspecies, *risi*, is the most successful zygopteran of the area, found in freshwater but becoming incredibly common around saltwater lakes, and extending south as far as Beijing (Samraoui et al. 2002). The status of the Eurasian *cyathigerum*-like taxa has been discussed by May (1997), and again by Samraoui et al. (2002), using a combination of morphology- and DNA-derived information. The conclusion is that *risi*, in spite of its well-defined male superior appendages, is a geographic subspecies of *cyathigerum*, not a bona fide species. As is customary with subspecies, clines should be expected wherever subspecies meet, and this is also the case with *risi* (Kosterin 1999). All specimens collected in Mongolia and Inner Mongolia turned out to be typical *risi*, except one among hundreds collected in loc. 7-8, which had *cyathigerum*-like male appendages. Clearly, such outliers should be expected to occur from time to time, and have also been recorded by Peters (1985). They cannot be considered to falsify the subspecific status of the population in which they were found. What remains to be done is to define where the morphological cline between the nominal subspecies and *risi* begins and ends. Judging from todays' evidence, it seems that Mongolia is at the far end of this cline.

Calopterygids are rare. *Calopteryx splendens* occurs in the small cis-Altai zone (see further) (Peters 1985), and also seems to be in the process of timidly pioneering up the Selenga valley (Malikova 1997). It has indeed long been known in the south part of the Lake Baikal basin (Belyshev 1973b). One of the most striking experiences to a 'western' odonatologist in Mongolia is to walk along the bank of most Rivers. In Europe and Western Asia, these would teem with *Calopteryx*, yet here they are completely devoid of them. Malikova (1997) additionally records *C. virgo* from Darchan in the north of the Selenga basin (River Haraa). This too is a significant record, and represents the easternmost reliable finding of this species. In eastern Siberia, it has been confused with *C. japonica* Selys. The two species do overlap; I found *C. japonica* in the north-western Altai, on small mountain lakes near Lake Teletskoe (unpubl.), together with A. Haritonov and O. Popova in July 1999. Ma et al.'s (1991) records of *C. virgo* almost certainly refer to *C. japonica* as well. Table 1 has been amended accordingly.

The most common and widespread species of *Coenagrion* is *C. lunulatum*, which I here figure after a male collected at Ulaan Bator (Figs 2-10). The specimen had the superior appendages strongly stretched out, making the heavy and plump basal tooth especially well visible. Also noteworthy is the rather strongly developed epiproct, which is bilaterally framed by a squarish outgrowth of the base of the superior appendage.

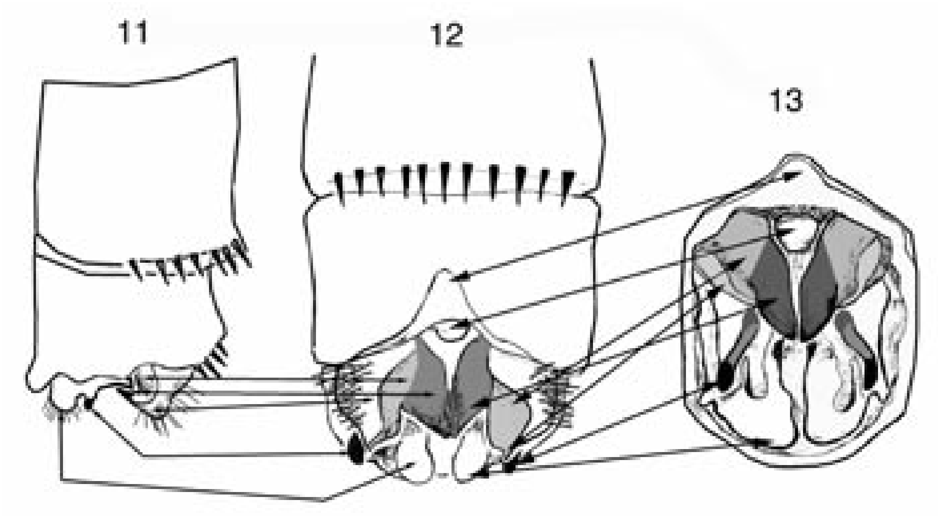


Figures 2-8. *Coenagrion lunulatum*, ♂ — (2) pronotum and adjacent zone of synthorax; (3) S1-3; (4) S7-10; (5) apex of Fw; (6) terminal appendages, lateral view; (7) terminal appedages, dorsal view; (8) terminal appendages, caudal view, arrows identify corresponding structures.



Figures 9-10. *Coenagrion lunulatum*, ♂ — (9) synthorax, colour markings; (10) head and synthorax, dorsal view.

Such characters are rarely used in the taxonomy of coenagrionid genera, yet they may be significant in better characterising genera. The delimitation of *Coenagrion* against *Cercion*, for example, is currently still unclear, although molecular data (H.J. Dumont & P.H.H. Weekers unpubl.) suggest that both are distinct genera, while the group of about six east-Asiatic *Cercion*, in turn, is only remotely related to the type species of the genus, *C. lindenii*, and will require a new name. In Figures 11-13, I show the male terminalia of *C. v-nigrum* from Primorye. As in all *Cercion* that I have seen, the basal tooth of the



Figures 11-13. *Cercion v-nigrum*, ♂ (Primorye, Russia) — (11) terminal appendages, lateral view; (12) dorsal view; (13) caudal view, arrows indicate corresponding structures.

superior appedages is longer and less plump, while the epiproct is smaller and not fitted between outgrowths of the base of the superior appendages.

In Anisoptera, aeshnids are rare in numerical abundance in the north, and scarcely less so in the south. Oddly, the only odonate listed in the Mongolian Red Book (Ministry for Nature and the Environment of Mongolia 1997) is an aeshnid: *Aeshna juncea*. Whether this choice is justified is a matter for further discussion. Although not a single species found in Mongolia is endemic, it would seem that, rather than protecting species, certain zones would need to be considered for conservation. Under such a scenario, the cis-Altai or Bulgan valley would rank high on any list of priorities.

Gomphids, plentiful in China and Japan, are limited to the Eurosiberian *Ophiogomphus spinicornis* in the Selenga catchment, and *O. reductus* in Bulgan province and the Gobi area. Kosterin (1999) re-examined photographs of Peters' specimens, provided by Richard Seidenbusch, and identified them as *O. reductus*, a 'Dzungarian' species, not as 'European' *O. cecilia*. *O. spinicornis*, a large gomphid with a well-delineated morphology, was comparatively common in the valley of the Selenga and its major affluents. Animals frequently settle on the ground and on stones; stray specimens were even seen along lake margins. *Gomphus flavipes* too occurs in the cis-Altai zone. *Nihonogomptus ruptus* (Selys) was found on the Russian side of the Onon River, close to the Mongolian border, by Belyshev (1973). Kosterin (1999) did not find it here, perhaps due to lack of forest cover. Yet, together with *Coenagrion glaciale* (Selys), this is a good candidate for future discovery on the Amur part of the Mongolian territory.

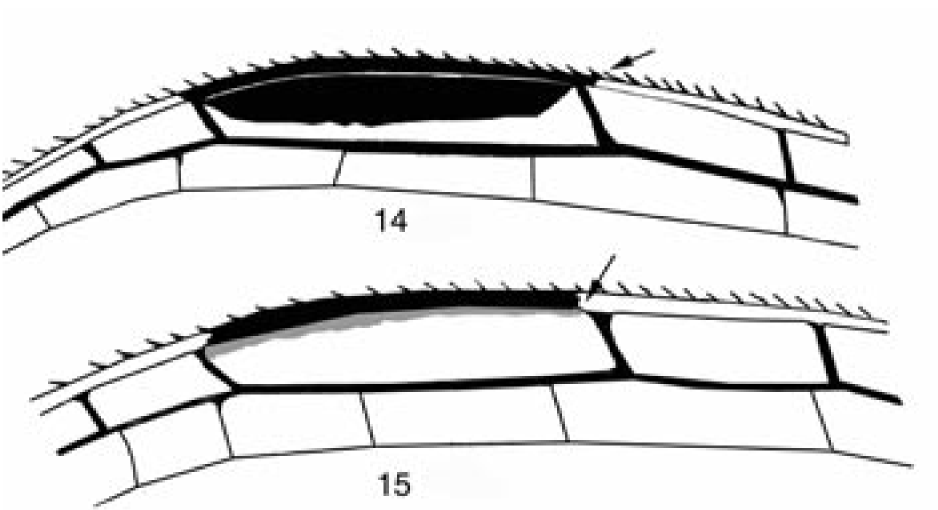
Corduliids are strikingly restricted to *Somatochlora metallica,* again in the cis-Altai zone. Several other species occur on the Siberian side of the Altai mountains (Belyshev 1973b; Kosterin 1999).

Libellulids are represented best, but the single genus *Sympetrum* (nine species found in our survey; 13 known in all) is largely responsible for this. Remarkably, and in contrast to, e.g. *Coenagrion*, which is represented by *only* Eurosiberian species, and *Cercion*, which is East Palaearctic, the *Sympetrum* are of different origin. Five species are Eurosiberian. One (*S. striolatum imitoides*) is an eastern subspecies of an Eurosiberian species. Specimens collected in Inner Mongolia were typical large and robust *imitoides*, but specimens from the Selenga were nearer ssp. *pallidum*, such that a cline is suspected to occur across the Mongolian republic. *S. fonscolombii* is a Mediterranean species with Irano-Turanian affinities, while two – *S. speciosum haematoneura*, new status, and *S.* sp. (*risi* ?), an uncaptured specimen being large, bright red, and having the wing tips extensively marked with brown – are East Palaearctic, extending from the Himalayas to Japan. *S. speciosum* was originally described from Japan (Oguma 1915), but subsequently also found in the mountains of Taiwan as a separate subspecies, *taiwanum* (Asahina 1951). Its close relationship to a Himalayan species, *S. haematoneura*, was recognised by Asahina (1984). As far as I can judge, *S. haematoneura* only differs from *S. speciosum* by the more restricted extent of the wing spot of the hind wings (photographed by Hamada & Inoue 1985). This also applies to the two specimens from Hohhot, in which the golden spot covers not more than the basal third of the hind wing. Consequently, I can see no reason to consider both as separate species. I have little doubt that *S. speciosum* extends outside of Japan, not only to Taiwan, but to the continent as well, where it reaches the Himalayas. A related species, *S. hypomelas* Selys, occurs across much of the same range, except Japan. It was described from the foothills of the Himalayas in Northern Bengal (Selys 1884), and was subsequently recorded from as far west as central Nepal to as Far East as central Inner Mongolia (Ma et al. 1991). I checked the types of Selys, figured by Ris (1911), and found both species to be quite distinct: they share the conspicuous two lateral bands on the synthorax (Figs 20, 27), but the male hamuli are very different. In *S. hypomelas*, the external branch is more pointed apically and extends further posteriad, and the inner branch is much shorter than in *S. speciosum* (Figs 22, 24-26). Ma et al. (1991) do not provide figures, and therefore it is theoretically possible that their record of *S. hypomelas* really refers to *S. speciosum haematoneura*, but, on the other hand, the co-existence of these two East Palaearctic elements in Inner Mongolia is not a priori improbable.

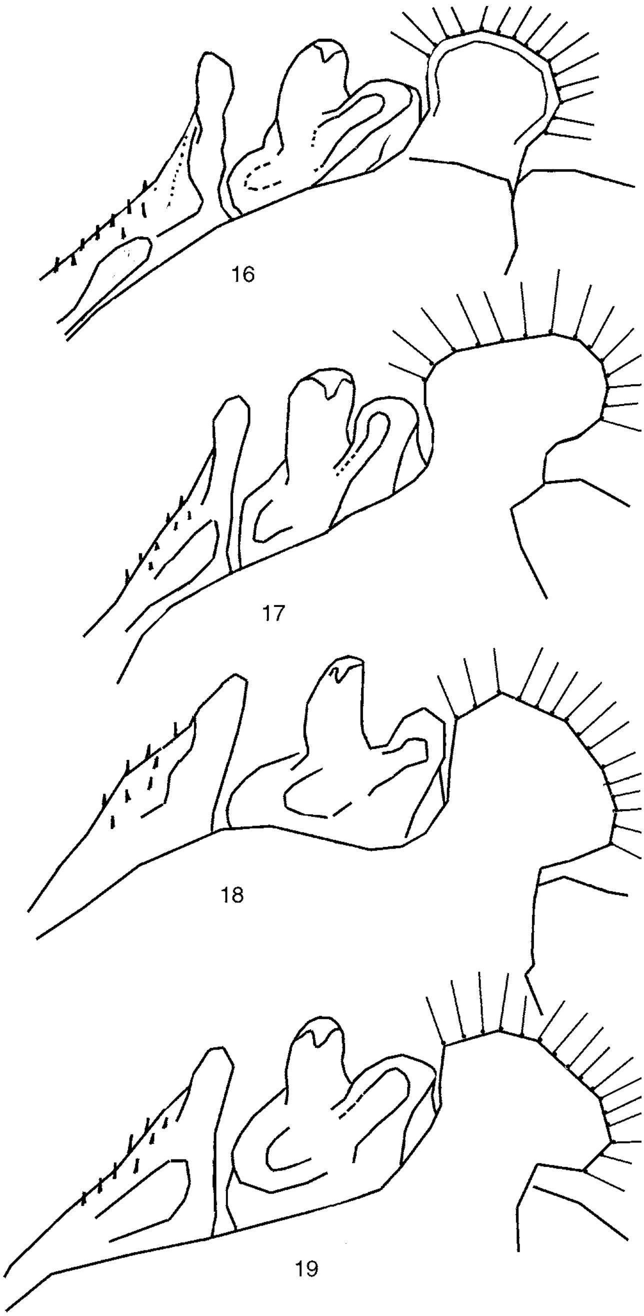
Deielia phaon is another typical East Palaearctic species. Eurosiberian species strongly dominate the picture, and are almost the only element found on the Mongolian plateau. However, in the Gobi desert and in Inner Mongolia there is an East-Mediterranean to Irano-Turanian representation that is significant: *Lestes barbarus*, *Ischnura evansi* and *I. pumilio*, and the above-mentioned *Sympetrum fonscolombii* as well as *S. meridionale* belong here. It is likely that these are connected to more western populations through the Dzungarian basin. Not much is known about the fauna of Dzungaria, largely situated in the north of the Chinese province of Xinjiang, but Jödicke et al. (1997) found that dragonflies such as *Orthetrum brunneum* live here; hence the region can function as a corridor for Irano-Turanian and other species originating in Kazakhstan and further west. Thanks to this passage, the range of *Lestes barbarus*, for example, extends several thousands of kilometres to the south rather than to the north of the Altai mountain chain. A record of *L. barbarus* as far north as the Middle Selenga valley (Malikova 1997)

is puzzling, however. Possibly, this vagrant species, that recently greatly expanded its range in Western Europe, has done the same in Mongolia and has moved north from populations in the Gobi area or south of it. However, in addition to these species typical of rather arid conditions, six Siberian species arch around the Altai and are limited towards the east by the Gobi desert, and towards the north by the Altai mountains. Within the Mongolian confines, they are only found in the small cis-Altai 'exclave' that was studied by Peters (1985). This fauna, composed of *Calopteryx splendens, Coenagrion puella, Aeshna grandis, Gomphus flavipes, Macromia amphigena* and *Somatochlora metallica* is well represented in the upper reaches of the Ob River and the West Siberian Lowland (H.J. Dumont pers. obs. in the Gorno-Altayskaya oblast of the western Altai mountains in July 1999). I predict them to be present in the intervening zones of Kazakhstan and Xinjiang as well. These six species, and probably a few others that await discovery, naturally reach their limit of south-eastward extent in the Bulgan basin.

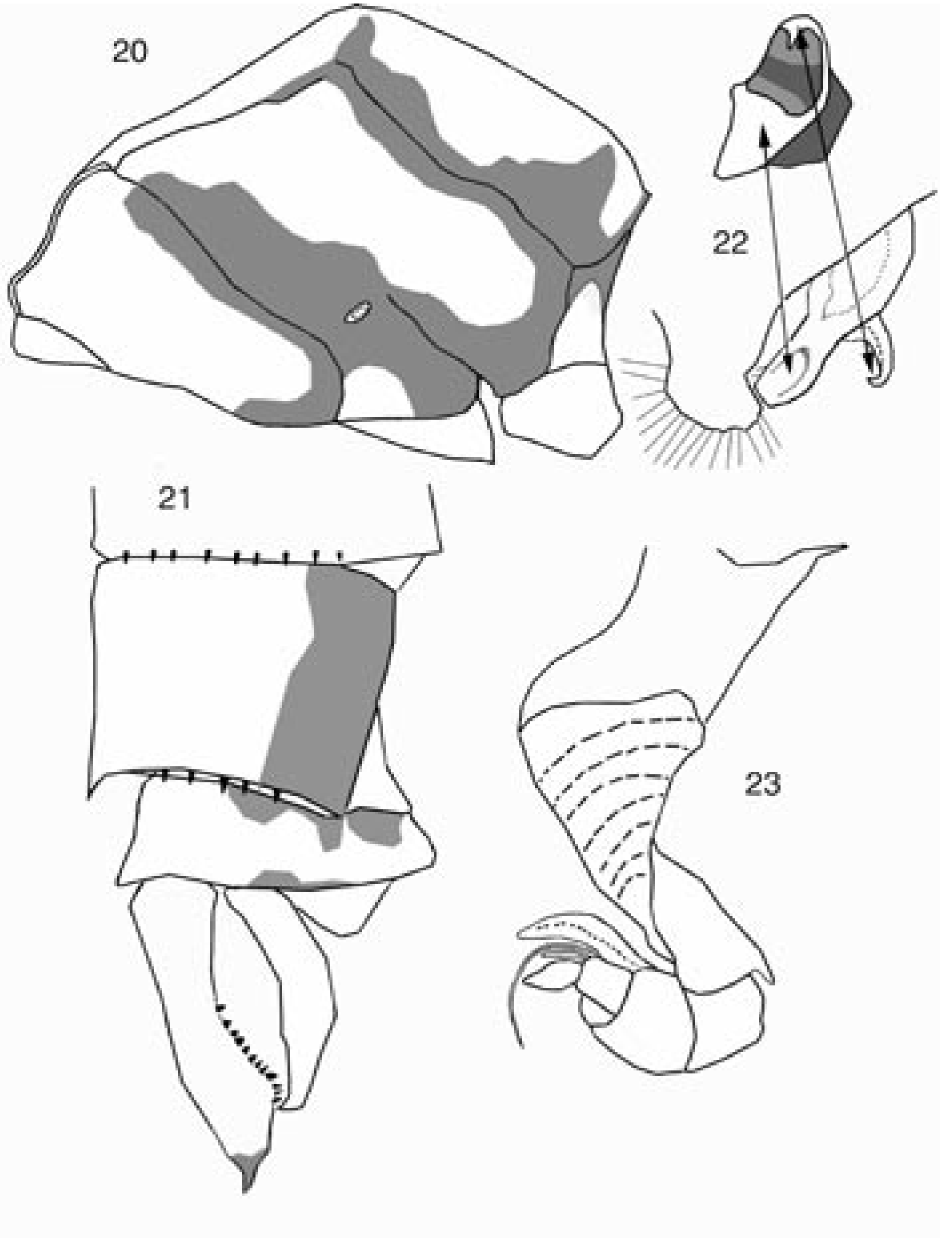
A number of species showing affinities to 'European' or 'Mediterranean' taxa appear racially different. A case in point is that of *O. brunneum lineostigma* (new status). This taxon was described as a new species by Selys (1886) from the Beijing area, and is chiefly characterised by its bicoloured pterostigma (Figs 14-15). However, Sui & Hun (1991) found this character to be displayed by only a few specimens of any population. This conforms to what I found: only one out of a series of eight specimens from Hohhot showed the typical condition. All of the others had only a faint, darker rim to the pterostigma, and the black upper vein a bit more broadly black than in Mediterranean specimens. Structurally, males perhaps develop a broader inner arch of the hamulus (Figs 16-17) than Mediterranean specimens (Figs 18-19), a tendency that also appears in Asahina's (1990) figure of a male from Korea. However, on balance there appears to be no reason to maintain *lineostigma* at the species level. The name groups the eastern populations of



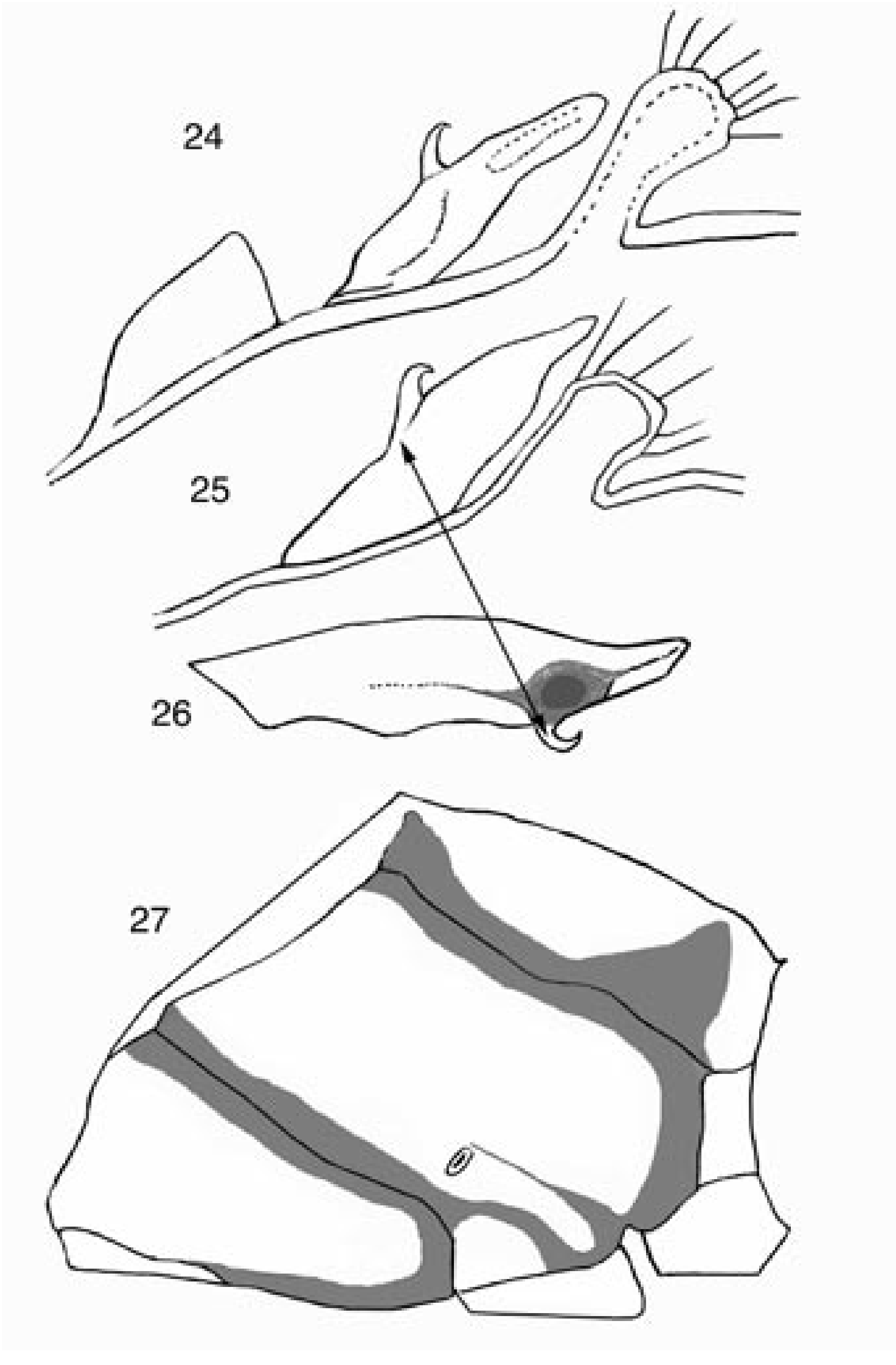
Figures 14-15. *Orthetrum brunneum lineostigma* — Pterostigma of two ♂ from a population at Hohhot, 23 June 1999.



Figures 16-19. *Orthetrum brunneum* sspp., accessory genitalia — of (16) the *lineostigma* specimen of Fig. 14; (17) the *lineostigma* specimen of Fig. 15; (18) a nominotypical ♂ from Ifrane, Morocco, August 1971; (19) a nominotypical ♂ from Baunei, Sardinia, Italy, July 1969.



Figures 20-23. *Sympetrum speciosum haematoneura*, ♂, Hohhot, June 1999 — (20) synthorax, lateral view; (21) terminalia, lateral view; (22) hamuli, lateral and ventral views, arrows indicate corresponding parts); (23) vesicula seminalis, lateral view.



Figures 24-27. *Sympetrum hypomelas*, ♂ — (24) accessory genitalia of a paratype, lateral view; (25) accessory genitalia of the holotype, lateral view; (26) idem, ventral view; (27) synthorax, lateral view.

brunneum, and both subspecies – *brunneum* and *lineostigma* – may be imperfectly connected by a string of populations in arid central Asia, such as the ones cited by Jödicke et al. (1997) from the Dzungarian depression. A similar remark has already been made regarding *Sympetrum striolatum imitoides*.

Typical oriental species, finally, are all but absent: the only species in Table 1 that really qualifies is *Orthetrum glaucum*. Wide-ranging, tropical-subtropical species are only slightly better represented: *Pantala flavescens* and *Ischnura senegalensis*.

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